

The IMPS Engineering lab

“**Engineering-** (n) A science by which the properties of matter and sources of energy are made useful to [humans] in structures, machines and products” - Merriam Webster dictionary

Introduction

The IMPS engineering lab is a project spread over two sessions where you will use some relatively simple ideas about dc circuits, optics, and the technology associated with silicon integrated circuits, to design and fabricate one or more devices on the "IMPS chip". This is a hands-on lab; each of you will make and test your own "chip", on 2 inch square piece of glass. An enlargement of the patterns you will create are shown in the figure at the end of this packet--you might take a quick look now. The black lines represent metal wires on the surface, and are also opaque to light. We will *not* be giving you much detail here about exactly what your devices can do; there are many possible applications using the patterns provided. Use your imagination and ask questions, and you may find your own application. Since this lab doesn't strictly follow the lectures, we've prepared this package of introductory/review material for you to read **before** coming to the lab -- you'll get more out the time you have with the equipment that way. *Note that there are problems for you to turn in at the beginning of the lab session.*

The two sections of the lab are:

- 1) photolithographic patterning of thin metal films on glass (information in this packet), and
- 2) device testing and characterization (another handout).

Overview

One device you could make can be viewed as a resistor with a microscopic gap engineered into it. We think it can be used to measure moisture on the surface of the sample, or the conductivity of any liquid placed across the gap. Possible applications are a dew point sensor (cool it until it shows a change due to condensation), or possibly a salt concentration meter. There are other devices you could choose which have optical functions, such as a diffraction grating or a position scanner for a laser barcode reader. *A challenge to you is to think of some possible applications, and let us know what supplies you need for the characterization session.*

One of the fun aspects of engineering is that it involves making design choices; there are many ways to make a sensor. The engineer has the chance to invent something that is better in some way than those others have made. You'll have some choice in which electrode pattern you want, how thick and how wide the wires are (and hence what their resistance is), what considerations you have to make in connecting the device to the macroscopic world, etc. You may also

decide to etch off all electrical wires and instead pattern grooves in glass; this can result in superior optical devices, at the expense of having no electrical devices.

The device testing session will bring all these pieces together; we'll use simple DC circuits to measure either the capacitance or resistance of the microdevice, and try whatever applications you've thought up.

Scheduling

Lab 1: You will (or have already) sign up for one of six sections of the photolithography during the next two weeks. Everybody will test their devices together the following week. **The lithography lab will meet in the Engineering building at the entrance to the microengineering lab cleanroom, 223 Cummings.** You will be working on this lab with Professor Levey at the Thayer School of Engineering.

GRP	LITHOGRAPHY (223 Cummings)	LAB 1
A:	2-4:30 pm	Wednesday January 31
B:	2-4:30 pm	Thursday, February 1
C:	6-8:30	Thursday February 1
D:	2-4:30 pm	Wednesday February 7
E:	6-8:30 pm	Wednesday February 7
F:	6-8:30 pm	Thursday February 17

Lab 2: We will all be together for this part, working in small groups. This way you each get to see the creative work of your fellow students. The lab will be **on Wednesday, February 14, in room 221 Cummings** (near the cleanroom). You will be able to sign up to start at **2pm, 4pm, or 6pm**, and continue for about four hours. We are not able to offer this lab during your ordinary IMPS lab time periods for logistical reasons, but we also prefer this single overlapping time period lab for pedagogical reasons. Each group will be devising a somewhat different device and testing approach, and you can learn a lot by exchanging ideas/results and demonstrating device operation for other student groups. Students really enjoy this culmination of their lab work.

Lab Writeup

You will write *one report for this pair of labs*. A more detailed handout on this is provided with the testing lab. We'll ask for a group report (you'll work in groups of 3-4 for device testing) of several pages, indicating your choices, why, what you did with it, and your tests. It should be short and sweet, not a re-iteration of the details of each fabrication step.